

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims

Claim 1 (Currently Amended): A method of polymerizing poly(cyclic)olefin monomers comprising:

(a) combining a monomer composition comprising one or more poly(cyclic)olefin monomers, a non-olefinic chain transfer agent and an optional activator compound in a reaction vessel to form a mixture; and

(b) adding a polymerization catalyst containing Ni and/or Pd ligated by a moderate ligand, the catalyst causing the mixture to polymerize;

wherein the non-olefinic chain transfer agent includes one or more compounds selected from the group consisting of H₂, alkylsilanes, alkylalkoxysilanes, alkylgermanes, alkylalkoxygermanes, alkylstannanes, and alkylalkoxystannanes.

Claim 2 (Original): The method of claim 1, wherein the non-olefinic chain transfer agent comprises alkylsilanes and/or alkylalkoxysilanes.

Claim 3 (Original): The method of claim 1, wherein the non-olefinic chain transfer agent comprises H₂.

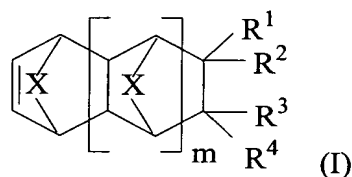
Claim 4 (Original): The method of claim 1, wherein an activator is present and the activator is characterized as having a functional group containing an active hydrogen with a pKa of at least about 5.

Claim 5 (Original): The method of claim 4, wherein the functional group is hydroxyl or carboxylic acid.

Claim 6 (Original): The method of claim 4, wherein the functional group is -OH.

Claim 7 (Original): The method of claim 4, wherein the activator is a compound containing an -OH functional group selected from water and C₁-C₂₄ linear, branched, and cyclic alkyl, aryl, and alkaryl moieties containing at least one hydroxyl group.

Claim 8 (Previously Presented): The method of claim 1, wherein the poly(cyclic)olefin monomers comprise a first monomer according to Formula (I):



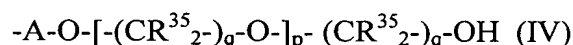
wherein X is selected from -CH₂-, -CH₂-CH₂-, O, S, and -NH-; m is an integer from 0 to 5; and each occurrence of R¹, R², R³ and R⁴ is independently selected from one of the following groups:

- a) H, halogen, linear, branched or cyclic C₁ to C₃₀ alkyl, aryl, aralkyl, alkaryl, alkenyl or alkynyl;
- b) linear or branched C₁ to C₂₄ halohydrocarbyls,
 -(CH₂)_nC(O)OR*, -(CH₂)_nC(O)OR', -(CH₂)_nOR, -(CH₂)_nOC(O)R, -(CH₂)_nC(O)R,
 -(CH₂)_n-OC(O)OR', -(CH₂)_nC(R)₂CH(R)(C(O)OR**), -(CH₂)_n(CR₂)_nCH(R)(C(O)OR**),
 -(CH₂)_nC(OR***) (CF₃)₂, -(CR''₂)_nOR, -CH₂-[O(CH₂)_n]_m-C(OR***) (CF₃)₂,
 -(CH₂)_nC(R)₂CH(C(O)OR**) ₂, -(CH₂)_nC(O)OH, (CH₂)_nC(R*)₂CH(R*)(C(O)OH),

$-(CH_2)_n-C(O)-O-R^{18}$, $-(CH_2)_n-C(CY_3)_2-OH$, and $-(CH_2)_nC(R^*)_2CH(C(O)OH)_2$; where each occurrence of R is independently selected from H and linear or branched C_1 to C_{10} alkyl; R' is a linear or branched C_1 to C_{10} alkyl or alkylol; R'' is selected from H and halogen; n and m^* are each an integer from 0 to 10; R^* represents an acid labile group cleavable by a photoacid generator; R^{**} is selected from R' and R^* as defined above and tertiary C_4 to C_{20} alkyl and cycloalkyl, C_1 to C_6 trialkylsilyl groups, and C_4 to C_{20} oxoalkyl; R^{***} is selected from H, $-CH_2OR'''$, $-C(O)OR'''$ and $-C(O)R'''$, where R''' is selected from methyl, ethyl, t-butyl, and C_1 to C_{20} linear or branched cycloaliphatic, R^{18} is selected from H, and linear, branched or cyclic C_1 - C_{24} alkyl, aryl, aralkyl, and alkaryl, Y is selected from F and Cl and at least one occurrence of Y is F;

c) C_1 to C_{30} linear, branched, or cyclic alkyl, aryl, aralkyl, alkaryl, alkenyl or alkynyl containing one or more hetero atoms selected from O, N, and Si;

d) a hydroxy alkyl ether according to Formula (IV):



wherein A is a linking group selected from C_1 to C_6 linear, branched, or cyclic alkylene, each occurrence of R^{35} is independently selected from H, methyl, ethyl and a halide, q is from 1 to 5, and p is from 0 to 3;

e) a group according to Formula (V):



where R^{36} is a linear, branched or cyclic C_1 to C_{30} , optionally partially or completely halogenated, alkylene, arylene, aralkylene, alkarylene, alkenylene or alkynylene linking group and Z is a functional group selected from hydroxyl, carboxylic acid, amine, thiol, isocyanate and epoxy; and

f) $C_rX''_{2r+1}$, wherein X'' is independently a halogen selected from fluorine, chlorine, bromine or iodine and r is an integer from 1 to 20.

Claim 9 (Original): The method of claim 8, wherein $m=0$.

Claim 10 (Original): The method of claim 8, wherein $m=0$, R^1 is the hydroxy alkyl ether according to Formula (IV), and R^2 , R^3 , and R^4 are each H in the poly(cyclic)olefin monomer.

Claim 11 (Original): The method of claim 8, wherein A is methylene or ethylene, each occurrence of R^{35} is H, q is from 2 to 5, and p is 0 in the poly(cyclic)olefin monomer.

Claim 12 (Original): The method of claim 8, wherein $m=0$, X is $-CH_2-$, R^1 , R^2 and R^3 are hydrogen, and R^4 is $-(CH_2)_n-C(OR^{***})-(CF_3)_2$ where n and R^{***} is as defined above.

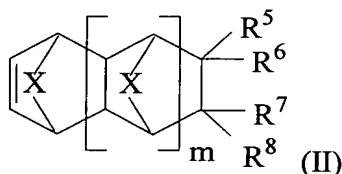
Claim 13 (Original): The method of claim 8, wherein $m=0$, X is $-CH_2-$, R^1 and R^2 are hydrogen and R^3 and R^4 are $C_rX''_{2r+1}$, wherein X'' is independently a halogen selected from fluorine, chlorine, bromine or iodine and r is an integer from 1 to 20.

Claim 14 (Previously Presented): The method of claim 1, wherein the poly(cyclic)olefin monomer is selected from the group consisting of α,α -bis(trifluoromethyl)bicyclo[2.2.1]hept-5-ene-2-ethanol, 5-norbornene-2-methanol hydroxyethylether, t-butylester of norbornene 5-carboxylic acid, hydroxyethylester of 5-norbornene carboxylic acid, trimethylsilane ester of 5-norbornene carboxylic acid, 5-norbornene-2-methanol acetate, 5-norbornene-2-methanol, 5-norbornene-2-ethanol, 5-triethoxysilylnorbornene, 1-methylcyclopentyl ester of 5-norbornene carboxylic acid, tetrahydro-2-oxo-3-furanyl ester of 5-norbornene carboxylic acid, and mixtures thereof.

Claim 15 (Original): The method of claim 8, wherein the acid labile groups, denoted R*, in the poly(cyclic)olefin monomer are selected from the group consisting of -C(CH₃)₃, -Si(CH₃)₃, isobornyl, 2-methyl-2-adamantyl, tetrahydrofuranyl, tetrahydropyranyl, 3-oxocyclohexanonyl, mevalonic lactonyl, dicyclopropylmethyl, dimethylcyclopropylmethyl and mixtures thereof.

Claim 16 (Original): The method of claim 8, wherein R** in the poly(cyclic)olefin monomer is selected from the group consisting of tert-butyl, tert-amyl, 1,1-diethylpropyl, 1-methylcyclopentyl, 1-ethylcyclopentyl, 1-butylcyclopentyl, 1-methylcyclohexyl, 1-ethylcyclohexyl, 1-butylcyclohexyl, 1-ethyl-2-cyclopentenyl, 1-ethyl-2-cyclohexenyl, 2-ethyl-2-adamantyl, trimethylsilyl, triethylsilyl and dimethyl-tert-butylsilyl, 3-oxocyclohexyl, 4-methyl-2-oxooxan-4-yl, and 5-methyl-2-oxooxolan-5-yl.

Claim 17 (Previously Presented): The method of claim 8, wherein the poly(cyclic)olefin monomers further comprise a second monomer according to Formula (II):



wherein m is an integer from 0 to 5; X is selected from -CH₂-, -CH₂-CH₂-, O, S, and -NH-; R⁵ to R⁸ are independently selected from H, -(CH₂)_n-C(O)OR", -(CH₂)_n-OR', Si(OR')₃, -(CB₂)_n-OC(O)R", -(CH₂)_n-OC(O)OR", -(CH₂)_n-C(O)R', -(CH₂)_nC(R*)₂CH(R*)(C(O)OR**), -(CH₂)_nC(R*)₂CH(C(O)OR**)₂, -C(O)O-(CH₂)_n-OR' and -(CH₂)_n-O-(CH₂)_n-OR', wherein n is independently an integer from 0 to 10; B is hydrogen or a halogen; R* is independently hydrogen, a halogen, C₁ to C₁₀ linear or branched alkyl or cycloalkyl, or C₁ to C₁₀ linear or branched halogenated alkyl or cycloalkyl; R** is independently C₁ to C₁₀ linear or branched

hydrogen with a pKa of 15 or less, and a carboxylic acid substituents selected from the group consisting of those in accordance with the formulas $-(CH_2)_qC(O)OH$,

$(CH_2)_qC(R^{25})_2CH(R^{25})(C(O)OH)$ or $-(CH_2)_qC(R^{25})_2CH(C(O)OH)_2$, wherein q is an integer from 0 to 10 and each occurrence of R^{25} is independently selected from H, halogen, linear, branched or cyclic C_1 to C_{10} alkyl, and linear, branched or cyclic C_1 to C_{10} halogenated alkyl; and

wherein at least one of R^9 to R^{12} is a carboxylic acid substituent as described above.

Claim 22 (Original): The method of claim 21, wherein $m=0$ in the third monomer.

Claim 23 (Original): The method of claim 21, wherein the groups R^1 to R^4 and R^9 to R^{12} in the poly(cyclic)olefin monomers of Formula (I) and Formula (III) are independently selected such that three or more poly(cyclic)olefin monomers are included in the monomer composition.

Claim 24 (Previously Presented): The method of claim 1, wherein the chain transfer agent is one or more of an alkylsilane or alkylalkoxysilane selected from the group consisting of Si-H containing cyclotetrasiloxanes and compounds according to the formulae $HSiR^{48}_3$, $HSi(OR^{48})_1R^{48}_2$, $HSi(OR^{48})_2R^{48}_1$, $Si(OSiR^{49}_3)_4$, and mixtures thereof, wherein each occurrence of R^{48} is independently selected from linear, branched or cyclic C_1 to C_{10} alkyl and each occurrence of R^{49} is independently selected from H and linear, branched or cyclic C_1 to C_{10} alkyl, where at least one occurrence of R^{49} is H.

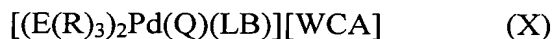
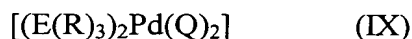
Claim 25 (Original): The method of claim 24, wherein the alkylsilanes are selected from the group consisting of triethylsilane, tri-isopropylsilane, and mixtures thereof.

Claim 26 (Original): The method of claim 1, wherein the combination of the monomer composition and catalyst is heated a temperature sufficient to effect polymerization.

Claim 27 (Original): The method of claim 26, wherein the mixture is heated to a temperature of from 30 to 150°C.

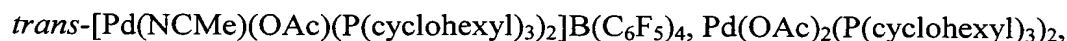
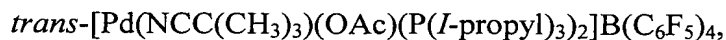
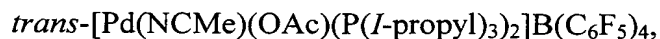
Claim 28 (Original): The method of claim 1, wherein the polymerization catalyst comprises Pd.

Claim 29 (Original): The method of claim 1, wherein the polymerization catalyst comprises a catalyst according to one or both of Formulae (IX) and (X):



wherein E is a Group 15 element from the Periodic Table of the Elements, R independently represents hydrogen or an anionic hydrocarbyl containing moiety; Q represents an anionic ligand selected from a carboxylate, thiocarboxylate, and dithiocarboxylate group; LB represents a Lewis base; WCA represents a weakly coordinating anion.

Claim 30 (Original): The method of claim 1, wherein the polymerization catalyst is selected from the group consisting of



$\text{Pd}(\text{OAc})_2(\text{P}(i\text{-propyl})_3)_2$, $\text{Pd}(\text{OAc})_2(\text{P}(i\text{-propyl})_2(\text{phenyl}))_2$,

trans- $[\text{Pd}(\text{NCMe})(\text{OAc})(\text{P}(\text{cyclohexyl})_2(t\text{-butyl}))_2]\text{B}(\text{C}_6\text{F}_5)_4$ and mixtures thereof.

Claim 31 (Original): The method of claim 1, wherein the polymerization catalyst comprises Ni.

Claim 32 (Original): The method of claim 1, wherein the molar ratio of monomer to catalyst is from 200:1 to 200,000:1.

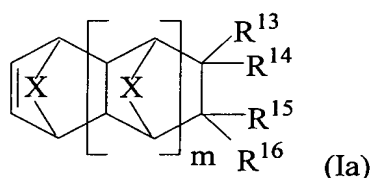
Claim 33 (Original): A poly(cyclic)olefin polymer prepared according to the method of claim 1.

Claim 34 (Original): A poly(cyclic)olefin polymer prepared according to the method of claim 8.

Claim 35 (Original): A poly(cyclic)olefin polymer prepared according to the method of claim 17.

Claim 36 (Original): A poly(cyclic)olefin polymer prepared according to the method of claim 21.

Claim 37 (Original): An unsaturated monomer comprising Formula (Ia):

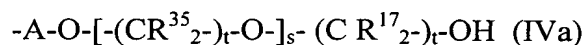


wherein X is selected from $-\text{CH}_2-$, $-\text{CH}_2\text{-CH}_2-$, O, S and $-\text{NH}-$; m is an integer from 0 to 5; and each occurrence of R^{13} , R^{14} , R^{15} and R^{16} are independently selected from one of the following groups:

(a) H, C_1 to C_{25} linear, branched, and cyclic alkyl, aryl, aralkyl, alkaryl, alkenyl and alkynyl;

(b) C_1 to C_{25} linear, branched, and cyclic alkyl, aryl, aralkyl, alkaryl, alkenyl and alkynyl containing one or more hetero atoms selected from O, N, and Si;

(c) a hydroxy alkyl ether according to Formula (IVa):



wherein A is a linking group selected from C_1 to C_6 linear, branched, and cyclic alkylene, each occurrence of R^{17} is independently selected from H, methyl and ethyl, R^{35} is independently selected from H, methyl, ethyl and a halide, t is from 1 to 5, and s is from 0 to 3; and

wherein at least one of R^{13} , R^{14} , R^{15} or R^{16} comprise the hydroxyalkyl ether of Formula (IV).

Claim 38 (Original): The monomer of claim 37, wherein $m=0$, R^{13} is the hydroxy alkyl ether according to Formula (IVa), and R^{14} , R^{15} and R^{16} are each H.

Claim 39 (Original): The ethylenically unsaturated monomer of claim 38, wherein A is methylene or ethylene, each occurrence of R^{17} is H, and s is 0.

Claim 40 (Original): A polymer comprising repeat units derived from the monomer according to Formula (Ia) of claim 37.

Claim 41 (Original): A negative tone photoresist composition comprising:

- A) a solvent;
- B) a photosensitive acid generator;
- C) a crosslinking agent containing one or more functional groups; and
- D) one or more negative tone imaging polymers comprising the polymers according to claim 34, wherein the polymers contain one or more functional group containing moieties having a functional group that is reactive with the functional groups of the crosslinking agent.

Claims 42-60 (Cancelled)

Claim 61 (Previously Presented): The poly(cyclic)olefin polymer of claim 36, wherein the polymer has an optical density of less than 0.2 abs/ μ m at an exposure wavelength of 193 nm.

Claim 62 (Cancelled)

Claim 63 (Original): The poly(cyclic)olefin polymer of claim 33, wherein the polymer has an optical density of less than 0.2 abs/ μ m at an exposure wavelength of 193 nm.

Claim 64 (Cancelled)

Claim 65 (Original): The poly(cyclic)olefin polymer of claim 34, wherein the polymer has an optical density of less than 0.2 abs/ μ m at an exposure wavelength of 193 nm.

Claim 66 (Cancelled)

Claim 67 (Original): The poly(cyclic)olefin polymer of claim 35, wherein the polymer has an optical density of less than 0.2 abs/ μ m at an exposure wavelength of 193 nm.

Claim 68-75 (Cancelled)